DOCUMENT RESUME

ED 300 221 SE 049 716

AUTHOR Zimmet, Eva; Koethe, Rainer
TITLE Young Researchers. A Competition and Its History in the Federal Republic of Germany.
INSTITUTION Inter Nationes, Bonn (West Germany).
PUB DATE 86
NOTE 71p.; For related documents, see SE 049 714-717. Translation by John Fosberry. Photographs may not reproduce well.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Competition; Foreign Countries; *Program Descriptions; Science Activities; Science Education; Science Experiments; Science Projects; Secondary Education; *Secondary School Science; *Student Projects; *Student Research
IDENTIFIERS *Science Olympiad; *West Germany

ABSTRACT

In the 20 years since the inauguraion of "Jugend forscht" (Young Researchers) over 26,000 boys and girls have taken part in this annual Olympiad of young innovators. This brochure gives an insight into the diversity of themes dealt with by the "Jufos" (young researchers) and into their ability to achieve astonishing accomplishments with the simplest of means and a lot of horse-sense. This brochure also provides information on the history, structure and procedure of this competition and illustrates with a few examples what former "Jufos" have now become. (Author)

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Eva Zimmet and Rainer Köthe

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Young Researchers

A competition and its history in the Federal Republic of Germany

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In the 20 years since the inauguration of "Jugend forscht" [Young Researchers], over 26,000 boys and girls have taken part in this annual olympiad of young innovators. The brochure gives an insight into the diversity of themes dealt with by the "Jufos" (young researchers) and into their ability to achieve astonishing accomplishments with the simplest of means and a lot of horse-sense. But the brochure also provides information on the history, structure and procedure of this competition and illustrates with a few examples what former "Jufos" have now become.

Young Researchers

A competition and its history in the Federal Republic of Germany

by
Eva Zimmet and Rainer Köthe

1986 INTER NATIONES Bonn

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Photos: Peter Thomann, Hamburg
Translation: John Fosberry
Layout: Stefan Rohl, Bonn
Printed by: SDV Saarbrücker Druckerei und Verlag GmbH, Saarbrücken
Printed in the Federal Republic of Germany

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What is "Jugend forscht"?

They reached a point where they had had enough. Fifteen-year old Sabine Schlegel from Swabian Lichtenstein and her brother Christian, 17, didn't want to go on breathing the petrol fumes and diesel stench wafted into their father's car by the ventilation system. They resolved to do something about it.

First of all, with the help of test tubes similar to those used for alcohol tests, Sabine and Christian measured the content of poisonous gases such as carbon monoxide in the moving car – and found alarmingly high values: "Especially when in a traffic jam or driving through a tunnel, the air got stuffy," says Christian, "the concentration of gases was eight times higher than the law allows for workplaces." And Sabine: "For a lot of people, their car is their workplace. The engine gets filtered air. Why not the occupants, too?"

The air filter which the two contrived and tested in many months of work not only retains the fine dust containing large quantities of poisonous lead, soot and carcinogenic asbestos from brake lining abrasion, but also destroys the dangerous exhaust fumes with the help of active carbon and a small catalyst unit. And that for just about 200 Deutschmarks. "If it were batch-produced, our filter would be even much cheaper," says Sabine. "Most people spend a lot more for completely superfluous car accessories."

The good idea and its clever execution made a good impression: In the "Jugend forscht" [Young researchers]

competition, the two not only won first place at national level and an award of DM 3,000 in the special prize category "Working World", but also received an additional award from the Federal Ministry for Research and Technology.

For 20 years now, this competition for the advancement of the rising generation of scientists, which is organized by the Federal German government, German industry, the schools and the periodical "Stern", has attracted young participants who simply take pleasure in research: computer freaks and environmentalists, mathematical geniuses and stargazers, rock collectors, electronics hobbyists and animal lovers. The object of this competition is not to track down wonder children, much less to foster a "research elite", but simply to give support to the tinkerers: those who are curious, ask questions and, at no great material expense but with dexterity and ideas, curiosity, imagination and "home-made" devices, investigate their environment.

Sabine (15) and Christian Schlegel (17) won the national-level prize in the field "Working World" in 1985 with their air-filter for cars.

More than 2,000 boys and girls – elementary pupils and students, secondary pupils and apprentices – take part every year in the preliminaries to have their work in the fields of biology, chemistry, geo and space sciences, mathematics/informatics, physics, technology and the "working world" judged by a jury of experts.

"Our existence is being determined to an ever-increasing extent by the findings of science, in a positive and a negative sense", says the scientific journalist Dr. Thomas von Randow, who initiated this competition over 20 years ago. "I believe it has never been so important as at present to undertake practical work in the field of the natural sciences, even if it is only for fun without any intention to make it your profession later on."

However, "Jugend forscht" was not established to promote criticism of science. The object was rather to remedy an urgent lack of students of the sciences.

The History of the Competition

"Jugend forscht": It is an undertaking that was born of necessity. In the middle of the nineteen-sixties, in a period of scientific euphoria, universities, government research institutes and even industry suddenly sounded the alarm: There was a lack of new blood. Too few young people wanted to study scientific subjects. No wonder, for in replanning curricula the ministers of education had treated the sciences rather niggardly. On top of that there was the traditional educational ideal according to which an educated person had to be familiar with Goethe's early lyric poetry, but not with the structure of the atom.

The solution of the problem: a competition for young researchers, male and female, like the "Science Fair" already practiced successfully in the United States for 16 years, ought to be called to life in Germany. The illustrated weekly "Stern" supported this idea and in 1965 Henri Nannen, its then editor-in-chief, called for participation in the "Olympiad of Young Researchers": "A country in which science lags behind will be a developing country in 2000 A.D."

The success exceeded all expectations. 224 boys and 20 girls competed in the very first round for the prizes offered.

From the outset, the main emphasis was on ingenuity and creativity. What was sought was not expensive apparatus, but ideas – and often things in everyday use sufficed to translate them into practice. This had no adverse effect on the diversity of themes. There are now but few things from the fields of

science, technology and everyday life which have not formed the subject of the investigations of a young researcher at some time. The spectrum extends from the "Magnetic Susceptibility of Transitional Metallic Complexes" to the question "Why do cut apples turn brown – and how can it be prevented?"

The "Jufos" (as the young researchers are called in competition jargon) have a reputation for accomplishing astounding achievements with extremely simple means and a lot of gumption. For instance, the bio researchers mostly turn up at the competitions with preserving jars full of living things, chemists investigate the composition of, say, candy colorants with little more than filter paper and a few glass cylinders, the physicists can mostly be recognized by the wired maze of their constructions, the engineers build with meccano sets, and the mathematicians even make do with pencil and paper, but cram their exhibits full of complicated formulae.

The "Jugend forscht" idea soon proved a grand success. The two first national winners, Maria Klein and Theodor Hildebrandt, took part with their entries in the American "Science Fair" in Dallas, Texas; against a field of 417 fellow competitors, they succeeded in winning several prizes, visited Cape Canaveral space terminal and shook hands with the German rocket pioneer, Wernher von Braun.

In the ensuing years, the number of participants increased steadily. In 1985, more than ten times as many boys and girls took part as in 1966. At the same time, however, the organizational and financial requirements also grew. And because the advancement of upcoming scientists is a matter for the general public, in 1975 the "Stern" campaign became a government campaign: Since that time, the competition is the responsibility of the non-profit society "Jugend forscht e. V." The Federal ministries for education and science and for research and technology provide a large proportion of the funds needed annually. The remainder is borne by industrial firms and "Stern".

1966 "Jugend forscht" winners Maria Klein and Theodor Hildebrandt with Henri Nannen (left), the founder of "Jugend forscht" and then editor-in-chief of the illustrated weekly "Stern".

Successful ideas spread rapidly. Since 1969, there has been the additional competition category "Schüler experimentieren" [School-age Experimenters], which is intended to give girls and boys under 16 years of age the same chances of participation as the young researchers. The idea of these junior preliminaries is to encourage younger persons, too, to occupy themselves with science and technology, though they are held only at regional level. In the same year, "Stern" donated special prizes for talented scientific authors under 30. This has now developed into the independent competition "Reporter der Wissenschaft" [Reporters of Science].

The subjects tackled by the young researchers and the young reporters reflect the developments of our times. The "Pollution of the Rhine at Worms", for instance, was in 1967 one of the first environmental themes. Their number increased steeply as the eco debate gained impetus; at present, they dominate the "Jufo" competitions. In consequence, since 1986

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1985 "Jugend forscht" winners with Henri Nannen (left) and Rolf Winter (right), the present editor-in-chief of "Stern".

there is a new special prize for works on environmental protection.

The advances in microelectronics are also reflected in „Jufo" work. While in the early years the computers were homemade, from the nineteen-seventies onward bought small computers found their way into hobby basements and studies; now, not only the informatics specialists benefit from this versatile tool.

"Jufos" are always at the forefront of research and some of them – thanks to the energetic support of the space industry – were able to send out automatically controlled experiments into orbit in order to find out, for example, how plants or crystals grow under gravity-free conditions.

P. 12/13: National-level winners 1984: Oender Aynaci (18) and Stefan Lacher (18). Their subject: "More safety in oxyacetylene welding" (Field: "Working World").

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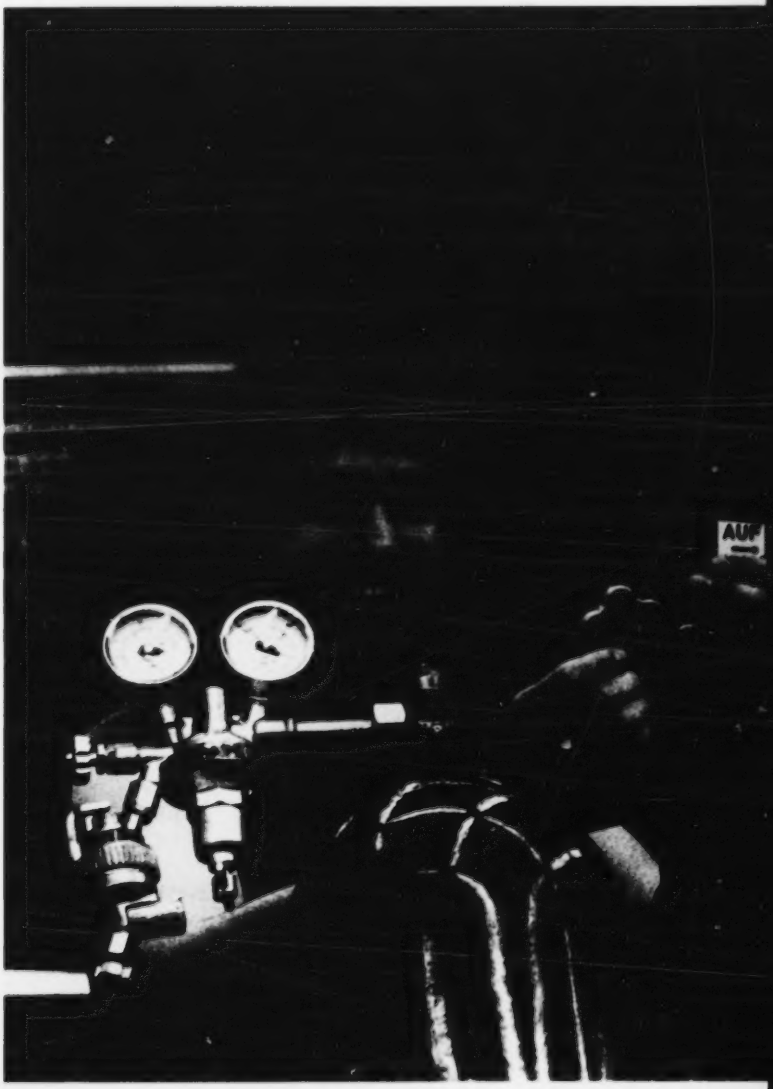

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The typical "Jufo" of the early years was a secondary school pupil and male. The number of primary and intermediate school pupils increased only slowly. In the course of time, the girls, too, discovered their bent for nature and their ability to research, especially in the fields of biology and chemistry. Despite all appeals, however, their share is still far removed from the dream goal of 50 per cent.

Especially for apprentices, since 1975 there is the special prize theme "Working World". In this category, awards are made above all for good ideas and efficient aids for the design of workplaces, improvement of tools and protection against accidents on the job.

A questionnaire survey of former "Jugend forscht" winners showed that the "Jufos" are not specialists with single-track minds; on the contrary, they have an abundance of interests. The ivory-tower dreamer is a type rarely encountered. "The young researchers are the mirror image of society and certainly exhibit just as much diversity as young people in general. In principle, they are nothing but young people who, for instance, play hockey or take an active interest in politics," says "Jugend forscht" executive Marianne Tidick, who has been organizing the competitions for over ten years. A strikingly large number play a musical instrument and are fond of reading even non-technical books. Their social and humanitarian involvement is less marked."

The reasons for taking part in the competition vary greatly. We find

- the highly talented pupil in the field of science or mathematics with very good marks, who feels that school does not demand his full capacity and therefore does work on the side;
- hobbyists with technical dexterity, but not necessarily any great theoretical knowledge. They are hardly encouraged at school and can give vent to their special talents in the "Jufo" work. Later on, they mostly take practical pro-

fessions such as engineer or technician;

- non-secondary school pupils who, to some extent for family reasons, have left school early, but feel that their apprenticeship does not demand their full capacity. This group includes, for instance, industrial chemists, laboratory technicians and apprentices.

It is worthwhile for all participants to take part in "Jugend forscht". Not so much on account of the money prizes: They are not very high, especially in the regional competitions (60 Marks) and in the state-level competitions (1st prize 300 Marks). Even in the nation-wide competition (1st prize 3,000 Marks) no riches can be gained, although at this level several generous special prizes can be won in addition, for example for ideas for saving energy or for particularly ingenious electronic contrivances. Furthermore, as "consolation prizes" there are numerous book gifts, periodical subscriptions and experimental sets.

Of greater importance than money are the immaterial prizes: guest stays in research laboratories of industry or research organizations, receptions given by the Federal Chancellor or the Federal President, an invitation to the Nobel prize-awarding ceremony in Stockholm (as a spectator!) and to the annual meeting of Nobel prize-winners in Lindau on Lake Constance, contact with other young researchers and with prominent scientists in the jury, the justified pride in recognized personal accomplishment. "Every successful participant has made a contribution in his youth to the great structure of science, a contribution recognized by the experts in his field", says the patron of the competition, Federal President Richard von Weizsäcker. "The pleasure in one's own achievement and the recognition are the finest rewards for his work."

And rightly so: Not infrequently, "Jufos" spend several months or even years on their work, sacrifice their spare time, put up with problems with their school and parents, cudgel

their brains, refuse to be discouraged by setbacks and experiments that miscarry. Such endurance is demonstrated only by those who take real pleasure in research – the few thousand Marks at the most which can be won could be earned more easily in other ways.

The danger that Germany might lag behind economically due to a lack of scientists is now nothing like as great as 20 years ago. In "Jugend forscht", therefore, the emphasis has meanwhile shifted more and more to imparting educational impetus. The intent is to make young people in all school types appreciate that nowadays knowledge of physics, chemistry, technology and biology are essential to understand life – even for those who do not subsequently study a scientific subject. The growing numbers of participants from year to year show that young people respect that intent.

For the future, executive Marianne Tidick hopes for a marked increase in young researchers: "Compared to the total number of schoolchildren in the Federal Republic of Germany, a bare 2,500 "Jufo" entries are insignificant. In this respect, a great task lies ahead of the teachers.

Structure and Schedule of the Competition

The "Jugend forscht" competition is based on concerted action by government, industry, schools and the press. It costs roughly two million Marks per year; the money comes at regional and state level from the sponsoring firms, at national level from "Stern" and the Federal government. A board of trustees, whose members include, inter alia, the federal ministers Dorothee Wilms and Heinz Riesenhuber, "Stern" editor-in-chief Rolf Winter, the chairman of the Donors' Association for the Promotion of Science and Humanities Dr. Klaus Liesen, and representatives of industry and the trade unions, watches over these funds.

The organization of the competitions and looking after the young researchers are the responsibilty of the seven women in the secretariat of the "Stiftung Jugend forscht e. V." [Young Researchers Foundation] in Hamburg. In addition, they compile and despatch information material, answer countless inquiries, collect the entries, maintain contact with industry, schools and jurors, look after the representatives of the press, radio and TV, and together with firms throughout the federal territory carry out the competitions.

Without the active support of the firms there would be no competition. Because "Jugend forscht" consists of a large number of elimination competitions at three levels. Between February and April, first of all the best entries are selected in the regional competitions, and they can then take part in the 11 state-level competitions. In each of the latter, one entry

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from each of the six special fields, the special prize category "Working World" and for the special "Environment" prize are admitted to the nation-wide competition in May, which lasts six days and is held in a different place every year.

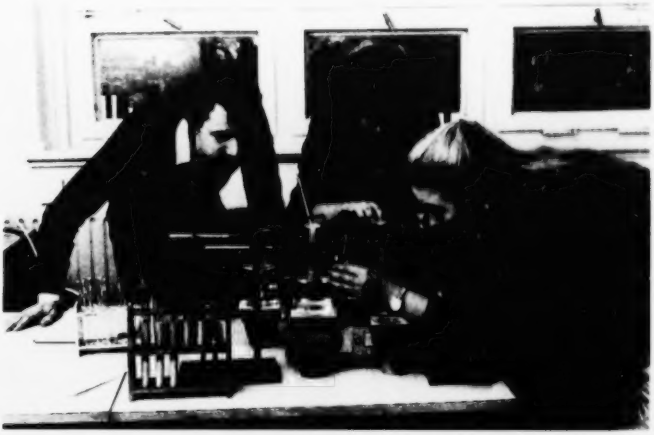
Each of these roughly three dozen "Jufo" competitions is organized by a sponsor firm: It invites the participants, provides overnight accommodation and board and rooms for the exhibition of the entries, arranges the festive prize-giving ceremony and arranges a supporting programme for "Jufos" and jurors. Numerous firms have participated for some years now: IBM, Daimler-Benz, MAN, MBB, Hoechst AG, Thyssen, Opel, Henkel, Nixdorf, Bayer, Ford, BASF and the Bitburger Bierbrauerei – to name but a few.

The firms extract scarcely any direct financial benefit from the competition; at best through the advertising value of the numerous articles in the press. For all that, of course, industry profits in the long run from the potential of inventive, scientifically interested pupils and apprentices who are given encouragement – a form of hedge for the future.

Nothing would work, of course, without the teachers. In many cases, it was they who first drew the "Jufos" attention to the competition. Voluntarily and without remuneration, they sacrifice their spare time, often make rooms available so that work on the "Jufo" entry can continue in the afternoon, give hints and help out with equipment, and finally accompany the "Jufos" to the competition. Above all, however, they arouse enthusiasm for taking an interest in nature.

How important the teachers are for the competition is demonstrated by the "nest phenomenon": Certain schools repeatedly bring out successful young researchers, while others are "Jufo barrens". The reason lies nearly always in the person of a certain teacher who encourages his pupils to take part in the competitions.

In the regional and state-level competitions, science teachers, together with practicians from industry, also make



Pupils of the Luisengymnasium (grammar school), Hamburg-Bergedorf, at work on their study "Influence of Environmental Pollutants on Plants" together with their teacher, Hans Küster.

up the jury. In the national-level jury, on the other hand, there are mainly university instructors, researchers from industry, and for each special field a former "Jugend forscht" winner.

There are three to seven jurors per special field. In some cases, for instance for particularly demanding or interdisciplinary subjects, further experts are called in.

It is by no means easy to establish a rank order for the entries, which mostly vary greatly. However, those who do not win one of the three main prizes in the national competition may possibly be granted one of the many special awards, for instance for "the most original entry", for investigation of "possibilities to save energy", for "an entry with a subject related to the postal services" or for an environmental theme.

Even before the competition proper, the jury may give its attention to the content of the various entries. Every young

researcher has to submit his entry in writing. For it is not enough to investigate some fantastic thing – as for every scientific publication, the findings have to be presented clearly and explained; the experimental set-up and the literature resorted to have to be enumerated. This gives the jurors the possibility of consulting scientific literature, checking data, repeating experiments, testing computer programs, comparing entries, and thinking over questions.

During the actual competition, the young researchers are examined very thoroughly: Did they really understand their theme? Did they carry out their experiments carefully and independently, without copying from some other source? Are their conclusions valid? Can they assess their work properly and critically and present it in an understandable manner? In the ratings, of course, consideration is given to the age and schooling of the young researcher. For the competition is not

Pupils explaining their work to the seven jurors for their special field, chemistry.

just an instrument for awarding prizes, but is an educational undertaking. The jurors are available, not only for technical discussions – and the "Jufos" gladly seize the opportunity of tapping the concentration of expert knowledge – but also for questions on the situation at the universities, on the choice of courses of study, or the situation on the labour market.

About 2,000 boys and girls enter the competition yearly. All that is necessary is a printed postcard (provided with information material) on which, among other things, the subject of the entry, the special field and the name of the supervising teacher have to be entered. Then, about one month later, the state-level competition directors invite the registered entrants to the first competition round and call for submission of their written entries. Up to the date of the actual competition, of course, supplementations and corrections are still possible.

The second step is the building up of the exhibition stand with which the entry can be presented. Here advertising talent is useful so that the problem, findings and experimental set-up can be presented in as clear and interesting a manner as possible – not so much for the jury as for reporters and laymen who view the stands and naturally have far less expert knowledge. In this respect, it is easiest for the biologists; with a little photographic skill they can present impressively the objects investigated – or they simply bring them along in an aquarium or terrarium. The mathematicians are mostly faced with far greater problems, especially when they have worked on out-of-the-ordinary, highly specialized problems and have only a few neatly written formulae with which to decorate their stand.

The "Jufo's" urge to research is subject to scarcely any restrictions. Only the use of dangerous chemicals, explosives, living poisonous snakes and other dangerous animals is excluded. Games programmes of aggressive military content are also impermissible. Of course, a young researcher must observe the Act on Prevention of Cruelty to Animals and the

rules of the German Association of Electrical Engineers concerning the safety of electrical equipment.

Despite all the excitement, for the "Jufos" the competitions are an impressive experience, even if they do not win a prize. The contact with like-minded people and the exchange of experience with them are equally important: "The social group I got to know in "Jugend forscht", the people I talked to, they were the society I like best in my whole life so far. I got along with them best of all," enthused a "Jufo", and a colleague found it "was just fantastic fun, sociable, and the meals were good."

The furthering of mutual acquaintanceship among all competition participants is one of the chief objects of the supporting programme, which comprises not only works tours, but also the famous "Jufo party" with dancing during the national competition. There they shake a leg and indulge in "shop talk" and in the process the "Jufos" not infrequently discover

Prize-giving: The spokesman of the national-level jury announces to the public, press and television representatives, and the "Jufos" the results of the jury's consultations and presents the winners' certificates.

they have similar private cares and worries: Problems with school or university vacancies, with the girl friend neglected on account of pressure of time before the competition, or even with parents whose suspicions are aroused by interminable preoccupation with the computer screen, bubbling and stinking glass flasks in the basement laboratory or wriggling vermin in preserving jars on the window sill.

The highlight, of course, is the concluding ceremony in the presence of prominent persons from politics and industry and with a supporting musical programme. The spokesman of the national jury announces to the public, the representatives of the press and television, and the young researchers on tenterhooks in the first rows the results of the jury's consultations, names the prize-winning themes, reads the laudations and in the blaze of press photographers' flashlights hands the radiant "Jufos" their certificates.

What happens in the competition?

Rocks have interested Ulf Hilzenbecher from Mörlenbach in the Odenwald ever since he was eight. After reading about "Jugend forscht" in a youth periodical, he took part three times; twice alone (in "school-age experimenters") and the third time, at the age of 14, together with a like-minded boy, Klaus Tandler, from a neighbouring village. Their work dealt with the geology of the anterior Odenwald, in particular with the "proof of a Graulian theory by experiments with rocks around the Kreuzberg/Rimbach". For non-geologists, the observations made by Ulf during the competitions are easier to understand: "Jugend forscht" seen with the eyes of a young researcher:

> As we are both downright lazybones, we already knew before the summer holidays what the title of the study was and what it was to describe. But we did not start with the collection of the exhibits, that is, rock specimens to underpin our theoretical ideas, until shortly before the Christmas holidays. This resulted in a few severely chilled hands and feet and the frequent comment "we'll never wait so long again".
>
> Next, we set about eliminating some false reasoning and misunderstandings in our concept. We began our written work at the end: First of all we completed the appendix. Then we had problems right away with the study itself, because again we waited until the last moment. On the last two days before the closing date, we were busy typing from

five in the evening to ten or eleven at night (to the annoyance of our parents). Then, half asleep, off to the letterbox and in with the envelope.

A few weeks later, the invitation to the regional competition arrived. First, a cry of joy, because it meant a day off from school, then two drooping heads, because we had to roll out of bed at half past five in order to arrive punctually in Frankfurt, where the South Hessian regional competition took place. We had no sooner arrived than we had to sign our names, because our travel expenses were reimbursed. Then we traced the exhibition stand marked with our names, hung up the sketches and positioned the exhibits. We didn't need to go hungry: We were able to stuff ourselves with rolls and drink Cola or lemonade (thanks to the sponsor firm, it tasted good).

Then the competition director welcomed the participants and introduced the jury. The first comments were made: "For God's sake, I know him", or "I hope he's as nice as he looks." Despite fears to the contrary, the members of the jury were nice and friendly to us. While they judged the entries, we retired to the exhibition stands, played cards, chatted with former "Jufos" from the national competition, played cards again, waited and trembled, spilt some lemonade, dried it all up again with rapidly procured toilet paper and a radiant heater borrowed from a stand of the "recycling group", and went on quaking.

The suspense increased, and suddenly two or three jurors were standing at our stand, introduced themselves and wanted to know more about our study. With every nerve tensed, we tried to make the report we had practiced at home – despite probing questions of the jury and diversion by other "Jufos".

At the end of half an hour, the questioning was over. We were left to ourselves again, did the rounds of the stands of other "Jufos", conversed with a lady representative of the

national competition directorate and with the sponsor's representative, played cards again and waited for lunch.

After the meal, representatives of public life and the press were announced. Occasionally a fellow in a corduroy jacket ran around with a camera. We found that the people from the press only talk to and photograph those who have a lot on their exhibition stand. If somebody brings along a cow complete with byre, for certain he'll find himself in the paper the next day, with a picture of the cow, but nothing about the "Jufo's" project.

Soon a small group who had discovered a "MacDonald's" from a window moved off. The rest played cards again or the intelligent-test game just distributed by the sponsor firm. Eventually the jurors had talked to all the "Jufos". While they went into consultation, we were shown a film. Around three-thirty followed the prize-giving ceremony with lots of welcoming addresses and speeches. A general sigh of relief on the appearance of the competition director, whose first words were: "I will not make a speech!" and who then announced the winners, that is, the entries chosen for the state-level competition. And our entry was one of them. Each of those participants, or each group received 60 Marks (which mostly served as a financial shot in the arm for the next study), a participant's certificate and a book. Then we cleared our stands ("Be careful, man, we need that again for the state-level competition".) and returned home.

At the state-level competition a few weeks later, the programme is a little bigger and it lasts a day longer. In between times, a team of reporters from the Hessian radio network appeared. On the second day, TV was there, too. In the evening, we caught a glimpse of ourselves on the screen.

With a drive around the works, the sponsor firm, Hoechst AG, wanted to show us all the things they make

and how big the plant is. I was most impressed by the electrolysis plant: A powerful magnetic field inside the facility makes the money in your pocket cut capers and a key thrown on the ground suddenly stands upright. It's a funny feeling when your pocket knife suddenly lies crosswise in your pocket.

We didn't get to our hotel before 11, because first we set out in search of a cosy tavern. There we sat chatting pleasantly with other young researcher, talking scientific "Jufo" jargon and recounting anecdotes about the last competition.

The following night we were invited to an evening visit to the Frankfurt zoo. Here a chameleon attracted our special attention: When we knocked on the glass, it nodded to us.

On the following day, several tabloids printed reports on the competition, which contributed to our general amusement. The prize-giving ceremony was opened by a paper by a scientist who spoke on current problems of atomic power. A few young musicians provided the musical accompaniment. Although our entry did not make it to the national-level competition: All in all those were two grand days.

Upshot: We met a lot of like-minded people, gained friends and came to realize that the other "Jufos", too, are not health-conscious milk-drinkers with sallow, stay-at-home faces, but people like you and me.

What "Jufos" investigate

The themes with which the knowledge-hungry boys and girls occupy themselves are of great diversity, and in seeking solutions they sometimes use new approaches which astound the experts – whether computers for the disabled are involved or the remedying of environmental pollution. Often it is problems of everyday household routine or on the job which give the impetus for a study.

For instance, the Herrmann family, who live in a single-family house near Ravensburg, were bothered for years by the heating system: "The plumbers had botched a bit when installing it and then we always had to pay the high oil bills," recalls Thilo Herrmann. Finally, he resolved to get the heating into shape on his own. Together with his father, he installed thermostat valves, insulated the radiator niches and adjusted the burner to the optimum.

In the process, his urge to research was awakened. With self-made and second-hand measuring instruments, he traced heat leaks in the system and considered how to stop them.

"The supply pipes alone waste up to 20 per cent of the energy, because they lie mostly in the basement or along the external walls," discovered Thilo. Finally, he developed a new type of heating control system – his control computer "knows", among other things, the number of radiators in operation and adjusts the supply temperature accordingly – and took part in "Jugend forscht".

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So the work brought a double reward: The Herrmann's oil bills were lower and, in addition, Thilo not only became national winner in the technology field, but also received the special "Energy-saving" award of 1,000 Marks and a research scholarship sponsored by the Fraunhofer Society.

Annoyances on the job are equally often the point of departure for a "Jufo" career; in this field apprentices predominate. There is probably no electronics hobbyist who has not burnt his fingers with a hot soldering iron or left a burnt spot in the table top – and resolved to be more careful in future. But Thomas Heinz, Norbert Brosch and Wolfgang Ewald from Opel's Rüsselsheim training workshop did not stop at good intentions; they designed a sliding guard for the hot tip. It not only protects the hands: "Now you can solder in a maze of wires without the iron melting off the plastic insulation of the wires," says Thomas enthusiastically. "And a soldering iron inadvertently left switched on over night can't cause a fire. " The simple solution costing a mere three Marks brought the "burnt children" a first prize in the field "Working World".

Young researchers have never fought shy of modern, complicated technology and so computers have been standard equipment for years now – especially since they have come within the reach of pocket-money recipients. At the last national-level competition, there were computers on one third of all exhibition stands – and by no means only on those of informatics specialists: Not only the computers themselves and their "innards" provide many themes, but also the things that can be done with computers.

The word has made the rounds among "Jufos" that computers are ideal, for instance, for helping the handicapped. The "Sascha" computer of Hamburg schoolboy Dierk Schleicher, for example, understands spoken words and figures and translates them into commands; with the comparatively simple and cheap electronic system, the physically disabled can

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The computer "Sascha" (system for analysis of voice sound) of the Hamburg schoolboy Dierk Schleicher understands spoken words and figures and translates them into commands.

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Thilo Herrman (Field: Technology) developed a new type of heating control system.

operate the telephone, radio, television, kitchen appliances or a wheel chair by remote control.

Michael Ristow from Lübeck has developed a computer program intended to help diabetics to cope with their illness better. His self-built microcomputer, after keying in the food units and the injected quantity of insulin, traces out the daily blood sugar curves, makes therapy and diet suggestions and indicates nutrition errors. Thus the feared late consequences of diabetes such as eye damage can be avoided more easily. "This work merits the highest recognition," praised the specialist jurors and awarded Michael, himself a diabetic, the Federal President's special prize "for an extraordinary piece of work". In the following year, the inventive hobbyist, together with multiple "Jufo" prizewinner Dirk Graudenz from Elmshorn, presented the logical, following step: a computer-controlled insulin pump as an "artificial pancreas". The patient need only program his daily schedule once every 24 hours and the computer does the rest. Initial therapeutic trials with this portable device have already proved successful.

Even such a complex field as the aerodynamics of a boomerang is approached by "Jufos" ingenuously and successfully – especially when they are motivated by anger. Horst Puschmann and Christoph Holzhey from Augsburg had bought such a wooden missile from a toyshop. But the purchase proved a bad investment. The boomerang flew, but showed not the slightest inclination to return to the thrower's hand. This atypical behaviour aroused the ire of the two schoolboys and they resolved to build a genuine, homing object.

That proved not exactly easy. The first specimens of the two "aeronautical engineers" flew practically no better than a piece of firewood. The 25th model, built after intensive study of the sparse boomerang literature, was the first to at least change its direction of flight in the air.

Further improvements, the two realized, called for exact

Michael Ristow and Dirk Graudenz developed a computer-controlled insulin pump, an "artificial pancreas".

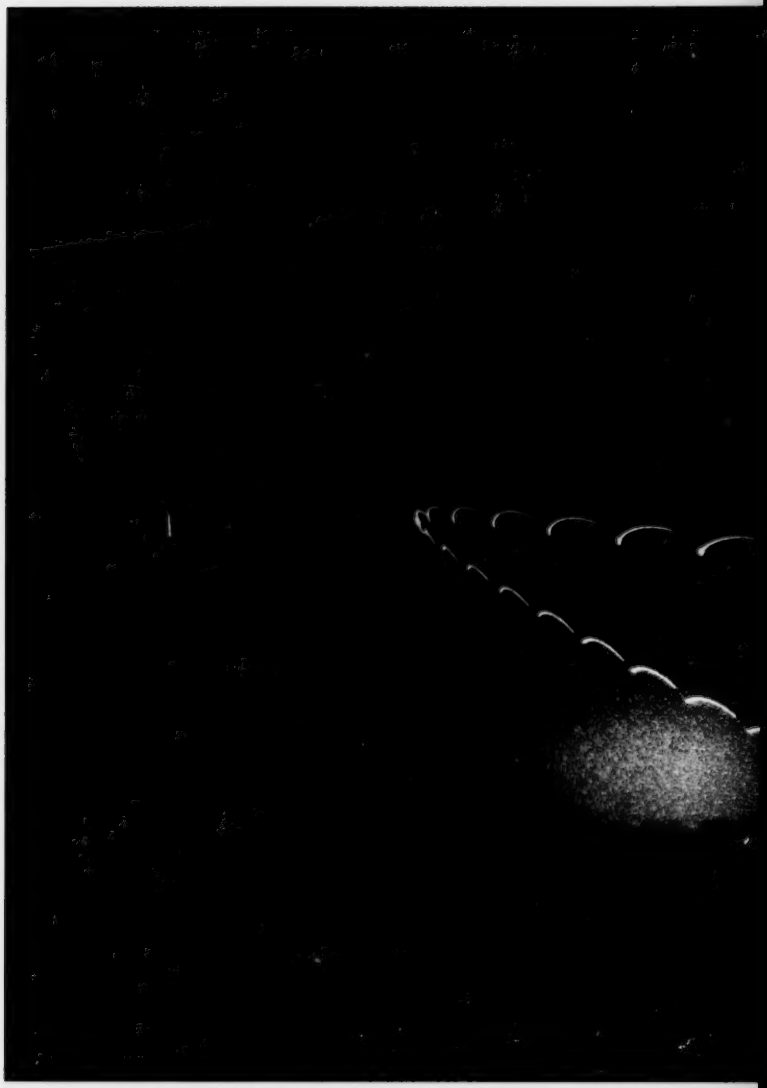
determination of the trajectory as a function of wing profile, weight and shape of the boomerang.

At this point at the latest, most hobbyists would have given up their attempts. Horst and Christoph, however, contrived an ingenious method of tracking the trajectory: A small pocket lamp bulb and a battery installed in the missile transformed the spinning wood into a gleaming Ufo, the light track of which they recorded with two cameras and evaluated with a home computer.

The throwing trials at night on a sports ground brought a double reward: In addition to a boomerang that flew well, a national win in the field of physics.

Not infrequently, "Jufo" studies take years, and especially behavioural researchers occasionally need the patience of Job:

P. 34/35: The national-level prize for physics was won by Horst Puschmann and Christoph Holzhey for their studies on the aerodynamics of the boomerang.



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235 hours, spread over four years, were spent by Martin Lewandowski, Matthias Hillmann and Norbert Lubenow in front of the orang utan cages at the Hanover zoo. First, in the old ape house and then – after the move to the new Jungle house – in front of the new orang utan enclosure. In the end, the observation records and evaluations filled several thick files. "We kept an exact record of the daily routine, movements, feeding and individual behaviour of the apes Uta, Niko, Daisy and Schorsch," explains Martin. "The old cages were small, rectangular and sparingly equipped; the new house is specially adapted to the way of life of orang utans in trees: It is much larger and provided with artificial trees, ropes, nets and plants much more like a jungle. In the new enclosure the animals behave much more naturally, they move about more, but retire repeatedly to places where they cannot be seen by the others. In nature, too, orangs are individualists."

The three young researchers inspired by their love for apes not only won the second prize in the field of biology, they were also accorded recognition as orang specialists: When the Cologne zoo was planning a new ape house, their findings were taken into account in the designs.

Side by side with computer entries, in recent years especially ecological themes have ranked high in "Jugend forscht". The "Jufos" not only track down abuses, but also try to do something for endangered flora and fauna.

While roving through woods and meadows, for instance, Peter Sonnabend from Neumünster occasionally found young birds which had fallen from their nests or met with accidents during their first attempts to fly. He tried to bring them up at home, but not always successfully: "Fledglings look quite different from their parents – and only the latter are illustrated in the ornithological books", found the young researcher. "So often I couldn't find out soon enough what the young bird ought to eat." In two years of work, therefore, the

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schoolboy compiled an "Identification and Rearing Key for Fledglings of all the 391 Species found in the Federal Republic of Germany", supplemented by hints on feed and care – a novelty in ornithological literature.

In 1981, the then thirteen-year old Armin Lude from Göppingen laid out a small pond with plastic film in his parents' garden. From then on he observed and identified the creatures that made the pond their habitat, kept a pond diary, regularly checked the water quality, took photographs and made microscopic examinations – for four whole years. Small artificial ponds without fish, found Armin, are important survival areas for endangered species of dragon-flies, frogs and newts; he decries the fact that in recent years more than 90 per cent of the small bodies of water have been eliminated by the drainage of moist areas and the filling in of "disturbing" pools with refuse and debris. His study shows that every

Martin Lewandowski, Matthias Hillmann and Norbert Lubenow developed into orang-utan specialists in their years of study of the behaviour of orang-utans at Hanover zoo.

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The then 13-year old Armin Lude kept a detailed pond diary for four years and demonstrated that small ponds without fish are an important survival area for many small animal species and insects.

Janine Fries (16) invented a gauze bag with a special filling with which flowing water can be freed from oil films.

garden-owner can give back a little living space to such animals by laying out a pond.

Incidentally, "Jugend forscht" is not "for men only": Ever more girls are taking part and, thanks to their preference for biology and chemistry, often submit impressive studies particularly on the subject of environmental protection.

All the world is talking about the death of forests. Marion Bischoff from Weinheim and Yvonne Krigisch from Fürth wanted to do more than listen to complaints, they wanted to help trace the causes. So they sought out an area of woodland with dying trees, laid out a network of measuring points with the help of a layout plan, and for months, also in winter, regularly determined the acidity of the precipitation and the soil. In this way they were able to track down a major malefactor – acid mist which occurs regularly at a certain altitude and destroys trees and the soil there.

Janine Fries from Illertissen directed her efforts to protection of waters. "A thimblefull of oil can contaminate over

2,000 litres of water," states the dedicated nature preserver. She had observed that in car workshops sawdust is used to absorb oil, and in a basement laboratory she tried whether that would also work on water. With negative results: "The sawdust became saturated and sank." Janine did not give up. For months she looked for possible ways of making sawdust "waterproof" – and finally found the solution in fine-ground quartz. Mixed with the sawdust it produced a binder that absorbs three times its own weight of oil. "If I pack the mixture in gauze bags and lay them out like a belt, I can even free flowing water from oil films," says the young chemist.

"Jufos" in Space

When the astronauts of the first German mission into space were orbiting the earth in November, something bleeped on board. The sound came from an experiment that two Hessian young researchers had handed over to the crew in the space lab. With the help of a commercial small computer, Markus Hoschek (18) and Jürgen Hundt (19) wanted to find out how the reaction time of the astronauts changed under the stress, lack of gravity and in the confined space in the space lab. Their device, programmed in months of work, generated acoustic and optical signals at irregular intervals, which the test subjects had to answer as quickly as possible by pressing a button. The reaction time was measured and stored together with the date and time of day.

But the two "Jugend forscht" prizewinners were not completely happy with their experiment: The astronauts found the game fun, but due to lack of time were only able to complete a quarter of the originally scheduled test runs. Over and above that, so far some of the data cannot be traced in the computer. "For all that, we hope to be able to start the statistical evaluation soon," says Markus. At least, their efforts have been rewarded by a trip to the USA: At the invitation of the computer manufacturer, they were allowed to receive their computer themselves after the landing of the space shuttle.

That was the second time that young researchers' experiments travelled into space. The "Jufo" ventures into space

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began on June 18, 1983, when five young researchers' experiments in a 150-litre container went into orbit in the cargo space of the Challenger shuttle. A special jury had selected them because they could function automatically and promised interesting results in orbit. The space on board was made available by Kayser-Threde, the Munich aerospace firm.

For the "Jufos", however, the selection of their experiments was only the beginning of the work: The devices had to be designed so that they functioned automatically, could stand up to loading tests and, lastly, satisfied the stringent safety requirements of the American space authority, NASA. Experts from Kayser-Threde helped the five young researchers to make their experiments "spaceworthy".

Three of the experiments took advantage of the absence of gravity:

Markus Hoschek (18) and Jürgen Hundt (19) sent a small computer out into space to test the reaction ability of the astronauts under gravity-free conditions.

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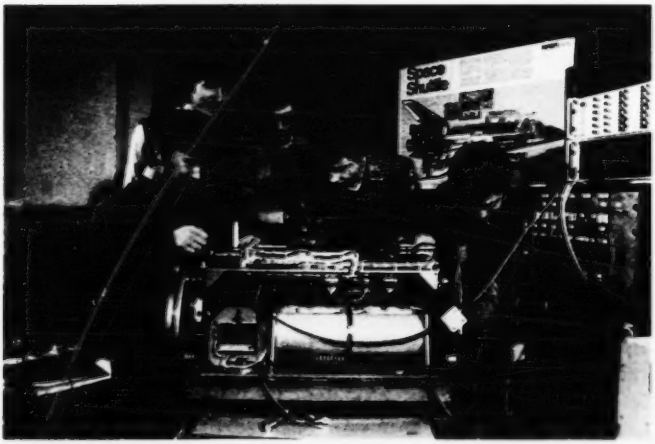

Herbert Riepl, Markus Buchwald, Gunnar Possekel, Michael Pascherat and Heinz Katzenmeier (l. to r.) also carried out "Jugend forscht" experiments with the space shuttle in space.

- Heinz Katzenmeier from Lautertal wanted to know how garden cress grows when information on "up"and "down" is lacking and to what extent they take up and store heavy metals from the nutrient solution. One of the most striking findings: Compared to plants growing on earth, the seedlings of the space cress exhibit for still unknown reasons an abnormal accumulation and enlargement of the hollow spaces between the individual cells.
- Michael Pascherat from Lippstadt in Westphalia investigated how crystals grow when disturbances due to upward and downward flows in the liquid (which can never be excluded on earth) are lacking.
- Crystal growth was also the subject of the experiment of Herbert Riepl from Dachau: Under gravity-free conditions he produced microcrystals of pure nickel; this heavy metal is capable of accelerating certain chemical reactions. Finding: Compared to a specimen produced on the ground, the

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nickel from space exhibited a much stronger acceleration effect.

- The experiment of Marcus Buchwald from Hildesheim dealt with the effect of cosmic rays, i.e. particles speeding through space, on the hereditary factors of grain seed. With regard to the execution, this was the simplest experiment: The seed was simply taken out into space; after the landing, Marcus carried out germination tests. Many of the irradiated seed grains, he found, did not germinate at all, while others produced stunted plants with peculiar deformations.

The fifth experiment, that of Gunnar Possekel from Garbsen, had nothing to do with weightlessness or cosmic radiation, yet it was of fundamental importance for the other "Jufos"; Gunnar built the computer that triggered the other experiments at the right time, monitored them and stored their measurement data. Because the astronauts on board the shuttle could not bother about the experiments; they gave only a few general signals, e.g. for the beginning and end of the mission. Special difficulty: Everything had to be ready two months before the launch, thereafter the "Jufos" had no further access to their equipment for organizational reasons.

In the future, too, "Jugend forscht" will be in space: Ten further experiments are already in preparation.

Schüler experimentieren (School-age Experimenters)

What nobody had considered probable at the beginning transpired soon after the introduction of the competition: The urge to research is present also in boys and girls under 16. Not only musical or chess geniuses display enthusiasm for their special field at the age of just five or six years, great researchers, too, recount that they took an interest in nature in their early school years. Many a pond-dabbler or butterfly collector later became famous biologists, many a stargazer an astronomer, and many a radio hobbyist a computer designer.

So in 1969, after four years of competitions, a special competition category, "School-age experimenters", was organized at regional level. It is intended to give young talents a chance to present their work and have it rated in competition with children of the same age. For it would be unjust to compare the work of an 11-year old schoolgirl with that of a 21-year old secondary school graduate. Incidentally: The youngest participant so far in "School-age experimenters" was a seven-year old girl!

It happens now and again that the jury upgrades a "Schüex" entry to "Jugend forscht", if it is felt that it has a chance. For the young researcher, of course, that is a great honour, even if he does not win an award, and an incentive to continue working and to try again in the following year. Not a few national-level winners have taken part three or four times before finally achieving their great success.

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Basically, the standards applied to entries for "Schüler experimentieren" are not all too strict, particularly since for this age group it is more difficult than for other young researchers to get hold of even relatively harmless chemicals and equipment, or even just to be taken seriously. The diversity of themes and the abundance of good ideas of these young researchers is therefore all the more surprising. Precisely the "Schüler experimentieren" competition has found particularly great interest among girls; their share is much higher than in "Jugend forscht".

Thirteen-year old Sophie Mützel from Berlin, for example, spent a whole winter investigating with small test rods the vitamin content of cellar-stored potatoes and potatoes bought as needed from a supermarket, and compared their prices. She found hardly any differences in the content of vitamin C, but discovered that supermarket potatoes were three times as dear as the cellar-stored ones.

More than in the case of the older "Jufos", household problems and observations give the impetus for the first "Schüex" research steps. Jutta Huber and Andrea Kimpel from Katzenelnbogen, both 15, were puzzled by the dirty layer formed on the surface when brewing tea. With simple chemical examinations they found that the film of dirt consists of tiny particles of calcium and occurs only where the water is "hard". The remedy was then clear: Water softening or a few drops of lemon juice, the acid of which destroys the calcium.

Ten-year old Nina Ulrich from Lehrte was continually vexed by spots on her clothes. Especially grease spots – not exactly a rarity in times when hamburgers, curry sausage and fried potato chips are the main food of many schoolchildren – often resisted the commercial spot removers. Reason enough for an inquisitive girl to tackle the problem systematically and start a major research programme: What sort of grease can best be removed from what material with what spot

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remover? The experiments showed that grandma's recipes were nearly always ineffective. But the commercial pastes, too, hardly bring the promised performance. One of the best and cheapest remedies, especially for fresh spots, proved to be cleaning benzine, but it is also the most dangerous because of its flammability.

It's nice to be a flower lover. And it's nice to go away on holiday. But for a flower lover who goes on holiday it is only nice, if you have someone to water the flowers or if you are a good amateur constructor like Kai Michalsky and Oliver Graubohm from Munster. They solved their problem with the help of electronics: A moisture sensor measures the plants' thirst and controls a small mechanical device, which allows a little water to flow from a reservoir into the flower pot.

Domestic animals, of course, cannot be simply looked after automatically during vacations. But observation of them affords a good opportunity of satisfying the urge to research.

Gabriele Rother, a 10-year old schoolgirl, from Oer-Erkenschwick discovered for instance, that her two dwarf rabbits "Tapsi" and "Stupsi" respond to colours: Best of all they like living in a hutch "papered" red. With training experiments, 13-year old Peter Daum from Schopp found that fish, too, can perceive and distinguish among colours. After holding a red cardboard disc in front of the aquarium during feeding for several weeks, the disc alone was finally sufficient to attract the fish to the feeding point. Discs of the same size in other colours, however, did not interest the fish.

People, too, can become the object of searching schoolchildren's curiosity. Tilman and Uta Wille, brother and sister (10 and 12 years respectively), tested the willingness of adults to help schoolchildren. The two asked altogether 301 persons

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P: 48/49: Ulrich Rögener at work in his hobby room at home. The 13-year old boy took part in 1985 in "School-age experimenters" in the field of astronomy.

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to show them the way, change telephone money, give telephone money or even pump up a bicycle, and recorded the reactions, age, sex and even the prevailing weather. Sun and rain, they found, have no influence on willingness to help, but the sex has: Tilman and Uta found three times more friendly men than women. But the result of a further test by the couple is far more dismaying. On the open street, they simulated severe pains: Of more than 1,500 adults passing by, a mere 12 paid attention to them!

Not infrequently, the "Schüex" jurors are astounded by the remarkably demanding themes of particularly young participants. For example, at the early age of 11, Mirko Krüger from Berlin devoted intensive thought to the origin of galactic clusters and their relationship to the mysterious quasars at the frontiers of space. Frank Ranostaj (12) and the one year younger Michael Maschke were fascinated by the riddle of prime numbers and investigated "Pythagorean prime power products". And over seven years ago, long before the debate on the death of forests, speed limits and catalysts, Volker Häusler and Folke Schriever from Kaiserslautern, then both 15 years old, measured the nitrogen oxide content of car exhaust gases as a function of driving behaviour – a question essentially the same as that investigated in the recently terminated large-scale inquiry of the Federal government into speed limits.

A particularly interesting study came from Mark Christ and Norbert Heimann, both 14 years old. They concerned themselves with the highly topical environment theme: The effect of dish-washing agents on small organisms. By way of an example, it is reproduced here in full. The impetus was given by an experiment in a television broadcast: In an aquarium full of water, a fish is swimming briskly. Dish-washing agent is added to the water. After a short time, the fish is dead.

"The death of the fish very much impressed, but also

Gunnar Brehm (13), too, was a participant in "School-age experiments". His special field is butterflies.

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depressed my friend and me. So we set out to find out for ourselves what damage is caused by the dish-washing agents that we use all too lavishly and as a matter of course every day", recounts Mark. "We wanted to perform four experiments: one with 'normal', one with environment-compatible dish-washing agent, each of them first undiluted and then diluted.

Our experimental "animals" were unicellular organisms. We chose these micro-organisms because at school it is forbidden to experiment with "higher" animals. The teacher who supervised us urged us – even with unicellular organisms – to kill as few as possible and to limit the experiments to a minimum. For the experiments with plants we used moss. We had accumulated sufficient knowlege about unicellular organisms and mosses in biology lessons.

First, we 'produced' unicellular organisms in a hay infusion: We put a little hay into a preserving jar and added a quarter of a litre of pond water and half a litre of mains water. We placed the jar in a room with a constant temperature of about 20 to 25 °C. After about 4 days, we could observe the ciliates under the microscope. Then we got some fresh moss and also the two sorts of dish-washing agent. We obtained the composition of the detergents from the labels on the bottles. We knew that they are water softeners and fat solvents. We diluted them in a ratio of 1 : 1,000, i.e., 1 millilitre of detergent to 1 litre of water. We also procured a microscope, slides and pipettes, and then we could start.

We carried out the experiments mostly in the breaks in the school laboratory. We proceeded as follows: In the first break, we prepared the slides; some with hay infusion and some with moss leaves. Then on each of the slides we placed drops of the different dish-washing agents in varying concentrations. With a stop-watch we measured the time up to

the occurrence of a reaction on the slides. In the next break, we continued in the same way. To obtain as accurate results as possible, we performed up to ten experiments on different days. What we wanted to find out was:

- How do organisms react to dish-washing agent?
- After what time does a reaction occur?
- Is "environment-compatible" detergent really less harmful than a normal agent?
- How can the use of dish-washing agent be restricted?

We carefully compiled the results of the experiments in a table and calculated the mean value. It was shown quite clearly that the unicellular organisms reacted most rapidly under the influence of the undiluted 'normal' dish-washing agent: After a bare three seconds, they all died; from some of them plasma flowed out of the burst cell membrane.

With undiluted 'environment-compatible' dish-washing agent, it took eight seconds for the unicellular organisms to die.

The mixture used daily by most housewives (and sometimes housemen, too) – that is, one millilitre of "normal" dish-washing agent to one litre of water – demonstrated its lethal effect after nine minutes, and the dilution with "environment-compatible" detergent one minute later.

The moss showed a reaction to the undiluted detergents only after several days and absolutely no reaction to the dilutions.

Our results did not turn out so spectacular as we had expected after the television broadcast. The housewife's customary mixture seems to have no effect on plants. Unicellular organisms and micro-organisms, however, are destroyed sooner or later by such detergent solutions, including the environment-compatible ones. To be sure, this 'mild poison' is diluted further in the sewer system. But then, together with the other pollutants in our waters, it contributes with a high degree of probability to diseases and

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the death of animals and plants. The unicellular organisms, the most sensitive to pollutants, are at the lowest level in the nutrition chain. Their death has unquestionable consequences for the entire biological cycle.

Now, what can we do with our newly gained knowledge? Appeals and posters certainly have little use. But may be the word will spread at home and among friends and acquaintances that we ought to be a little more sparing with the matter-of-course squirt into the washing-up water. To this end, here are a few hints:

- if possible, use only clean, hot water;
- use only half of the otherwise usual detergent quantity;
- cut only a small opening in the top of the bottle;
- dilute the bought detergent yourself;
- buy preferably environment-compatible detergent, although it is more expensive;
- and an appeal to industry: bring out soon a dish-washing agent that washes, but doesn't bite!"

Reporters of Science

What now ticks in atomic and hydrogen bombs was once pure, innocent physics. A chemist invented gas warfare. Anthropologists delivered the "scientific" groundwork for the racist mania in the Third Reich, and physicians stood on the ramp in Auschwitz and sorted out the victims. Nowadays, we are experiencing how technical equipment such as television sets, cars and computers change our way of life. Will the future bring "quarks" bombs? Will our enormous knowledge in the fields of biology and gene engineering be turned against us in the shape of horrible weapons some day? Will the advances in brain research be used to place man under tutelage, to make him a will-less slave of a "big brother"?

Science has become dangerous. If we do not want the results of research (often paid for with tax revenue) to be turned against us, we must be vigilant and keep a strict eye on researchers and on politicians and economic bosses. We must be able to voice our opinion when laws on foods or medicaments, on safety regulations for nuclear power stations or the transport of chemical wastes are debated. But for that it is necessary for the general public to be aware of the significance of science and research and to understand what goes on in the laboratories, for that is the prerequisite for critical debate.

To that end we need interpreters, competent, critical go-betweens who translate dry, scarcely comprehensible, specialists' jargon into an easily understandable, gripping and enter-

taining article that is a pleasure to read. But such scientific journalists are even rarer than scientists, for in addition to scientific interest they also have to have literary talent. The object of the "Reporters of Science" competition is to track them down and encourage them. This search for talent, for young scientific authors, has been going on for over ten years and the number of participants has grown continually.

On average, the jury of scientists and scientific journalists of high repute has more than 250 entries to judge every year, for which prizes of altogether DM 10,000 were available. Criteria for judging merit are, for example, topicality, originality and importance of the subject, liveliness of style and, of course, factual accuracy. What is sought is not a dry laboratory report (and certainly not a school essay or something copied from an encyclopaedia), but a well-versed, critical assessment of scientific endeavours.

Participation in "Reporters of Science" is open to everybody under 30 years of age who resides in the Federal Republic of Germany. Students, schoolchildren, and apprentices as well as scientists or journalists. A maximum of two entries may be submitted; but none longer than four foolscap pages.

Apart from the three main prizes, special awards are given, for instance for articles that are particularly suitable for magazines, the daily press or radio. The prizewinners are invited to Bonn and receive their cheques from the hands of the minister for research or education.

Not a few former "Reporters of Science" are now sitting in editorial or press offices, or work as freelance authors. The physicist Dr. Horst Güntheroth, for example, who in 1979 wrote about artificial climates, now works in the science department of the illustrated weekly "Stern". Egmont R. Koch, who took part in 1975 with an article on mice, is now a much-sought author of environmental bestsellers and television films. And Reiner Klingholz, whose article on insect

"Reporters of Science" prize-giving, 1985: Gabriele Ott received 2nd prize for the essay "Our Generation Knows No Remedy – 600,000 persons in the Federal Republic of Germany Suffer from Neurodermitis" from the hands of Heinz Riesenhuber, Federal Minister for Research and Technology.

decoy-substances ("The Scent that Lures into a Trap") won first prize in 1982, has switched from a biochemical laboratory to the editorial office of "Zeit-Magazin".

Not infrequently, "Jugend forscht" winners set pen to paper and demonstrate their talent in the field of scientific journalism. One example is Matthias Glaubrecht. In 1981, he won the third biology prize with his observations of the common buzzard. As a "Reporter of Science" he describes the problems which even a parasite has:

"To Blazes with the Cuckoo"

Year after year, the same drama is repeated: A female songbird has scarcely laid its eggs and left the nest for a moment before an alien egg is smuggled in and one of her own cluth is eaten.

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Everybody knows the bird in question. Its name stands for breeding parasitism par excellence. The curious breeding behaviour is as well-known as the unmistakable call that is the harbinger of spring – and of danger to the eggs of songbirds. The cuckoo lays about ten eggs in ten different nests, thus ensuring survival of the species. It leaves the trouble of raising its young to the host birds, which hatch the cuckoo's eggs at the expense of their own young and find it difficult to satisfy the ravenous hunger of the small parasite. And the thanks? The more successful the hosts are in raising the cuckoo the more likely they are to be plagued again in the following years. While still in the nest, the young cuckoo notes the appearance of its foster parents so that it can identify the species of bird later. However – and that has only been discovered recently: The afflicted host birds are capable of defending themselves. A master of self-defence is a brown-feathered songbird, a marsh reed warbler (acrocephalus palustris). It pecks a hole in the cuckoo's egg that has been foisted on it so that it can be seized by its beak and throws it out of the nest without further ado.

We owe our knowledge to the Hamburg ornithologist Dr. Karsten Gärtner, who spent over a decade patiently tracking down the cuckoo. At a riverside meadow in the midst of fens, his original intention was merely to find out why the cuckoo seeks out this marsh reed warbler less often than others as a host for its eggs. That is what other birdwatchers thought they had observed previously. But Dr. Gärtner found exactly the opposite: Because it proved that the cuckoo quite often lays its eggs in the nests of the acrocephalus palustris. Only the researchers had never really taken account of this small reed warbler, in contrast to the more than one hundred other known host birds; at best, it was listed as an occasional host. It was not only found that the acrocephalus palustris is regularly para-

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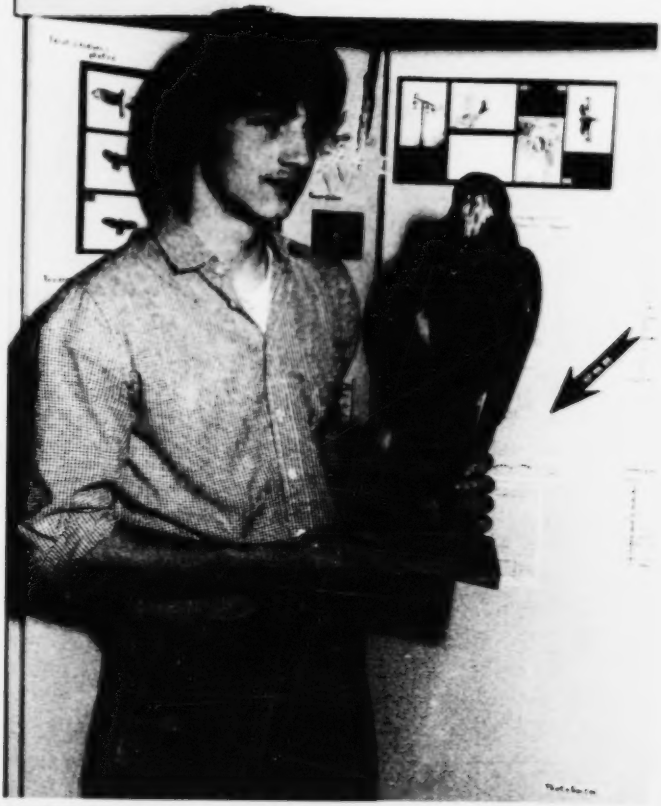
Biologie

Matthias Glaubrecht
2070 Ahrensburg

Dreijährige Untersuchungen
Mäusebussardpopulation (B
unter Anwendung einer indi



Matthias Glaubrecht won the third prize at national-level in 1981 in the field of biology for his investigations into the way of life of a common buzzard population. He has also made his mark as a "reporter of science".

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sitized and in the east of Hamburg developed into the chief local host; even more important is the unanticipated, inimical attitude to cuckoo's eggs.

Only people who are "early birds" can observe the behaviour of this small reed warbler. In summer, Dr. Gärtner set out in the early morning to check the many nests – in 12 years, 800 marsh reed warbler's nests. In the process he noticed how the cuckoo's eggs unexpectedly disappeared, as a rule three days after being laid. The acrocephalus palustris had carried them away and thus saved their own young. For otherwise the hatched cuckoo would soon have thrown them out of the nest, because it needs as much food as a whole brood of a marsh reed warbler.

But to make sure no mistakes are made: Not all of the marsh reed warblers throw the eggs overboard, but only 80 per cent. After all, 13 per cent accepted the parasite and 7 per cent of the birds deserted their nests. Cuckoos evidently find it difficult to gain acceptance by the acrocephalus palustris.

True, defensive reactions had previously been observed in other species of birds, but mostly in the shape of rigorous desertion of the clutch. The researchers now assume that ejection may be practiced by other hosts more often than was known up to now. A newly found clutch does not betray whether it had possibly contained a cuckoo's egg that has meanwhile been removed by the host bird.

The question of what induces rejection is a puzzle to the researchers. Presumably it is lack of adjustment in colouring and markings that is responsible for the early ejection. In the clutch, the cuckoo's egg is immediately obvious as a misfit. But while the closely related pond reed warbler (acrocephalus scirpaceus) nearly always accepts the so conspicuous cuckoo's egg, the marsh reed warbler (acrocephalus palustris) has probably learnt in the course of evolution to distinguish its own from strange eggs. It always threw

strange eggs from the nest, but never its own, even when Dr. Gärtner placed the very similar eggs of a field sparrow in the marsh reed warbler's nest and left only one reed warbler's egg. This confutes the thesis of rejection on the basis of recognition by discordancy. Presumably it presupposes too high a degree of abstractive capability to recognize an egg that deviates from the clutch. An interesting point is whether the knowledge of the species-specific egg type is actually innate or learned. In an experiment, half of the test birds accepted an alien clutch, if from the outset they had alien eggs in the nest instead of their own – imprinting of a strange egg type. Nevertheless, an egg newly laid by the bird, as described above, was never ejected. Is the pattern of the species-specific egg type innate to a certain extent? Or were the birds already imprinted in the previous year? In the final analysis, exact proof was impossible on account of lacking knowledge about the bird's fund of experience.

There remains the problem of egg adaption, which has bothered scientists for a long time. Is the breeding parasitism of the cuckoo highly evolved, since its eggs are to some extent very well adapted to very different host birds' eggs, or is the lacking adjustment to a specific host species and egg type (e.g. the marsh reed warbler) a primitive attribute and thus evidence of an initial stage of development? Later specialization could mean an evolutional cul-de-sac, whereas continual changing of hosts ensures broad distribution and a smaller risk.

A precondition for adaption of parasite eggs to the host eggs is selection by the host birds. For the latter, however, every successful repulsion of a brood parasite constitutes a selection advantage, because the parasite disturbs the propagation of the species.

As already mentioned: A cuckoo has no easy time with the marsh reed warbler. But for all that, it chooses its nest

again and again. Possibly because it is compelled to; for since many bird species which would accept its eggs are becoming ever rarer or even beginning to disappear entirely, it has better prospects, if it lays its eggs in the nest of the still abundant though resisting marsh reed warbler.

There is still a good deal to be clarified about the evolution of breeding parasitism. And the marsh reed warbler should be reason enough to reappraise our knowledge of the only apparently well-known cuckoo.

What became of former "Jufos"?

Since the establishment of "Jugend forscht" in 1965, altogether about 26,000 young researchers have taken part, and many of them have won state-level or national-level prizes. Dr. Hartmut Rahn, secretary general of the "German National Scholarship Foundation", found this a fitting occasion for a stock-taking: Had the competition attained the set objective? Did the young researchers actually become scientists?

There are some very tangible results. He found more than 1,600 scientific articles, 65 books, 362 contributions in compilations, 441 other publications and 98 patents. But how did the young researchers make out in their studies and in working life?

Rahn sent to 1,100 former "Jufo" state and national-level "Jufo" winners a questionnaire on the course of their education. 774 replied; the remarkably high response rate of 70 per cent proves, according to "Jufo" executive Marianne Tidick, "the close ties between the young researchers and 'their' competition".

The results of the evaluation turned out very well. It proved that not one of the prizewinners was a flash in the pan. 94 per cent of those former winners whose cards reached Rahn had completed scientific studies – though not always in Germany:

Andreas von Bechtolsheim recalls his four semesters of electrical engineering and informatics in Munich with horror:

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"It was awfully congested. 800 students crowded into our maths lectures. And mostly I couldn't get at a computer; they were reserved for advanced students." Above all, however, he missed the link between theory and practice: "Informatics in Germany is just theory, and in electrical engineering we heard nothing about computers."

So the national-level "Jugend forscht" winner in the physics field, whom the jurors had attested "theoretical comprehension combined with practical craftsmanship", went to Stanford University in San Francisco, where he studied computer construction and in 1982 at the age of 27, together with 3 friends, he founded his own firm – with great success: "Of all computer firms ever founded, our rise was the steepest. My shares are now worth about 30 million dollars", says the gangling, blond, ex-young researcher happily. He shares a two-room flat with a friend. "That's nothing extraordinary here; ten of my university class alone are already multimillionaires. That's the gold rush of the nineteen-eighties. In Germany, though, that's impossible".

Theodor Hildebrand, too, holds a similar opinion. The now 39-year old man took part in the very first "Jugend forscht" competition with a self-built small computer and was the first winner at national level. He is now a department chief in a French computer firm and links computers of banks, department stores and filling stations with each other by cable: "In this field, France is far ahead of Germany."

Just as in their schooldays, when they devoted their spare time to "Jufo" work, at university and in their profession "Jufos" do not steer the easiest course, but make extra efforts of their own initiative. For there is hardly a single "Jufo" for whom the competition was the cause of interest in nature or in research – in most cases, the partiality for biology, handicrafts or mathematics was awakened in their very early youth. In many instances an investigation was begun out of pure curiosity and submitted to " Jugend forscht" only later.

For example, Bettina Kitzinger, a Hamburg schoolgirl, simply wanted to know whether acupuncture really works, "and I thought, try it out". The then 17-year old girl learnt the technique of the small needle pricks from books and found that an electric current flowing between the needles is actually dependent on the paths of certain nerves and blood vessels and can be influenced by narcotics. In 1976, she was the Hamburg state-level winner with her study.

But her interest in the human body was there even before her "Jufo" success and determined her profession: She studied medicine, specialized on the heart and now, following a busy year of study at Guys Hospital in London, she is now carrying on research at Hamburg University Hospital on blood coagulation disorders. On the side, she also finds time for riding or sailing, and in addition plays the flute, recorder,

The former "Young Researchers" winner with the theme acupuncture, Bettina Kitzinger, studied medicine, specialized on the heart and is now working at Hamburg university hospital on coagulation disturbances of the blood.

piano and viola da gamba, and sings in the well-known "Capella vocale" choir.

Nearly all former young researchers owe their success to encouragement by a teacher who suggests, for instance, that they submit their annual assignment to "Jugend forscht". "At that time, our physics teacher encouraged us, saying we could always withdraw later," recalls Viktor Brantl. In 1969, together with his cousin, he had developed rockets of cardboard and wood, the propellant of which consisted of rolled-up newspaper impregnated with saltpetre. They flew to altitudes of up to eight kilometres and brought the two rocketeers the national-level prize in chemistry – and Viktor Brantl, thanks to an associated industrial scholarship, a course of study largely free from worries. Even today, he still holds his rocket patents, but his research interests have been transferred to medicine and biochemistry: As chief of a research group in a large pharmaceutical firm, the ex-young researcher is making investigations into new medicaments.

Strikingly often, the theme of the "Jufo" entry foreshadows the later vocation. Konrad Wothe from Munich, for instance, designed for the competition a panoramic camera, the lens of which consisted of a goldfish bowl filled with water. Today he is a successful animal movie maker, who has filmed several times in India and Africa, and recently made a documentary of a certain rare species of monkey in Central American Costa Rica.

At the universities, found Rahn, former young researchers are decidedly popular. They study unremittingly, zealously and with great success, and many complete their education in an astonishingly short time. Wolfgang Baumeister, for example, completed his biology studies within six semesters. Years ago, he spent just as long on his "Jufo" study of plant communities which develop on deforested areas.

Now, at the age of 38, he is a professor and carries on research at the Max Planck Institute for Biochemistry in

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Konrad Wothe, now a successful animal film-maker, designed while still a schoolboy a 360° panorama camera for the "Jugend forscht" competition, using a water-filled goldfish bowl as the lens.

Munich with the help of self-improved electron microscopes and image-processing, high-capacity computers on clarifying the structure of protein molecules from bacterial cell walls. "Jugend forscht", he feels, "is a good idea: 'Many students do not come into contact with scientific thought and work until they are at a university and occasionally they then discover – too late really – that that sort of work is not their line. That can't happen to 'Jufos'".

However, not all young researchers remain faithful to science. Peter Ruzicka from Hamburg, who won the national-level physics prize in 1968 with a study on the processing of sounds inside the human ear, attended a music academy, studied music and law, and is now manager of the Berlin Radio Symphony Orchestra, not only responsible for the artistic performances, but also the employer of 120 musicians and organizer of worldwide tours: "For me research was but an episode."

In 1968, Peter Ruzicka won the national-level prize for physics with a study on the processing of sound in the human ear. He is now manager of the Berlin Radio Symphony Orchestra.

All in all, concludes Hartmut Rahn, "Jugend forscht" winners also achieve above-average success in later life – though success is not necessarily expressed in dollars or Deutschmarks.

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